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Since we may assume the origin of the first system of ordinates arbitrarily, we may take

$$\Sigma x' = \Sigma y' = \Sigma z' = 0;$$

in other words, we take the geometrical center of gravity of the first body as the origin of our system of ordinates. Then

$$\Sigma x'' = \Sigma y'' = \Sigma z'' = 0;$$

i. e., the two bodies must be so placed that their geometrical centers of gravity coincide.

Provided the two forms are symmetrical, this result gives a complete solution of the problem. If the forms are irregular, the degree of torsion must be determined which will give the best result. In most cases the form in question will be symmetrical in at least one direction, so that torsion in one direction only need be considered. Starting with the geometrical center of gravity as the origin of a system of polar coordinates, we have for any given pair of points the coordinates l' and l'' as distances from the center, and α' and α'' as angles with the zero line. If we give the second system of points the torsion ξ , we find that

$$\Sigma \{l'^2 + l''^2 - 2l'l'' \cos (\xi + \alpha'' - \alpha')\}$$

must be a minimum; or

$$\Sigma l'l'' \sin (\xi + \alpha'' - \alpha') = 0,$$

$$tg\xi = -\frac{\Sigma l'l'' \sin (\alpha'' - \alpha')}{\Sigma l'l'' \cos (\alpha'' - \alpha')}.$$

Theoretically, the problem can, therefore, be solved. By using a limited number of well-selected points a good superposition of the two forms can be made.

Experiments, so far as carried out, indicate that alveolar point, nasion, bregma, lambda, basion and pterion give a good superposition of skulls.

It will be noticed that if this method is pursued the arbitrary element in composite drawings or photographs may be eliminated.

FRANZ BOAS.

XUALA AND GUAXULE.

THE location of two Indian villages, Xuala and Guaxule, mentioned in some form by all of the chronicles of Hernando de Soto's wild and unfortunate expedition (1539-41) through

the territory now included in the southern states, are important in determining the route of this Spanish adventurer. If the location of these two villages—especially the first—can be determined with reasonable certainty it will enable us to fix the route of the Adelantado with comparative accuracy from his landing place at Tampa Bay, Florida, until he reached the vicinity of Mauvilla in Alabama.

The widest variation in opinion of the numerous authorities touching upon the subject, relates to the position of Xuala; these views, however, may be classed in two unequal groups, as is evident from the following list: The map of Cornelius Wytfliet in his 'Descrip. Ptolemaica (1596)' locates this village on the west side of Savannah River near the head. DeLisle's map (1707?) in French's 'Hist. Coll. La,' though indefinite, places it west of the Savannah. Later authorities locate it as follows: Pickett ('Hist. Alabama,' I., p. 8); C. C. Jones, Jr. ('Hernando de Soto,' p. 13); Cyrus Thomas (5th 'Ann. Rep. Bur. Eth., p. 95); and Theodora Irving ('Hist. Cong. Florida,' II., p. 8), all locate it west of the upper Savannah in Nacooche valley, Habersham County, Georgia, or in that immediate vicinity. Mr. James Mooney (19th 'Ann. Rep. Bur. Eth.,' pt. 1, p. 195) and Woodbury Lowery ('Spanish Settlements within the United States,' p. 230, in the text, but not on the map) locate it in the 'piedmont' region of North Carolina, about the head of Broad river—which would be about Henderson County. Gilmore Shea in his article entitled 'Ancient Florida,' in Justin Winsor's 'Narrative and Critical History of America, II.,' follows, in this part of De Soto's route, the course given by C. C. Jones, Jr. Buckingham Smith on the map in his 'Narrative of De Soto' (Bradford Club Series, V., pl. 5) places Xuala about Habersham County, Georgia, but locates Guaxule to the northwest, apparently about Towns County of the same state, or possibly over the line, in Tennessee. Although Shipp ('De Soto and Florida') does not locate Xuala, he places Guaxule in Bartow County, Georgia, thus agreeing substantially with Pickett, Jones and

Thomas. The 'New International Encyclopedia' follows, in part, Mooney and Lowery, but also differs from them in part.

It will be seen from this list that the general consensus of authorities—all, in fact, but two or three—locate Xuala somewhere in northern Georgia, most of them in Habersham County, while Mooney and Lowery place it in southwestern North Carolina, somewhere in the region of Henderson or Rutherford County. Although the article 'De Soto,' in the 'New International Encyclopedia' apparently follows Mooney in locating Xuala, though it does not mention the name, it differs radically from them in regard to the immediately following portion of the route, carrying it down the Coosa, instead of the Chattahoochee. It is rather strange that Lowery on the 'Sketch Map' of his work locates Xuala in or near Habersham County, northeastern Georgia, and Guaxule about Bartow County, and follows down the Coosa River instead of the Chattahoochee as in his text (p. 230).

The object at present is to examine briefly the data and determine, if possible, which of these two divergent views agrees most nearly with the original chronicles of the expedition, and the topography of the country, or whether both are erroneous.

All the facts bearing upon this particular inquiry to be drawn from the original chronicles relate to the march from Cofitachiqui—where the Adelantado was so royally entertained by the noted cacica—to Chiaha, where he paused to recuperate because of abundant food and pasture.

It is now generally conceded that Cofitachiqui was located on the east bank of Savannah River, at or near Silver Bluff, about twenty-five miles below Augusta, though one or two authors have contended that it was at the junction of Broad and Savannah Rivers. We shall, therefore, proceed upon the assumption that it was at or in the vicinity of Silver Bluff—as this theory is maintained by the views we propose to discuss; calling attention first to that theory which places Xuala in western North Carolina.

From Cofitachiqui, according to all the original chronicles, De Soto and his army pro-

ceeded northward, without, so far as the records show, recrossing the river, hence on the east side of the Savannah, in what is now South Carolina. However, in order to procure a supply of food the army was divided into two parties, that with De Soto going directly onward, while the other turned aside, some twelve leagues, say the chronicles (probably toward the bottom land), where there was a store of maize offered them by the cacica.

Before reaching Xuala they passed through some small villages or settlements of the Chalaque (or Achalaque) now recognized as the Cherokees. The time given for the march from Cofitachiqui to the Chalaque by the different chroniclers differs considerably; Elvas states it was seven days; Garcilasso, eight; and Ranjel (in Oviedo), only two. Biedma does not mention Chalaque, but makes the time occupied in going from Cofitachiqui to Xuala eight days. As further data regarding the time occupied, it may be stated that Elvas makes the time from Cofitachiqui to Xuala twelve days. Ranjel makes it seven days, mentioning as an intermediate village Guaquili—not noted by the others—which he says was three days' march from Xuala. Garcilasso makes the distance between the same points fifty leagues. All agree in giving the time from Xuala to Guaxule as five days.

As the particular view we are now discussing is that maintained by Mr. Mooney and Mr. Lowery (in his text) and the latter follows the former without going into details, for these we have necessarily to refer to the statements by the former.

According to these the Chalaque villages were probably on or near Keowee River, for which point we may assume Anderson, Anderson County, South Carolina, as among the modern names along the supposed route. From this point the Adelantado's force proceeded to Xuala, which this authority, as already stated, places about Henderson County, North Carolina. From there, according to both authorities, they moved west, 'down French Broad' River as far, we are justified in supposing (as no point is mentioned), as to or near the site of Asheville. From there these authors carry them southwest to

White County, Georgia, where they arrive at Guaxule. This route, if traveled by De Soto as this theory supposes, was according to the geologist of the U. S. Geological Survey, who has been at work in that section, most likely, as follows: Using modern names to designate the points; from Anderson, South Carolina, to Greenville, same state, 26 miles; thence across Blue Ridge to Hendersonville, North Carolina, 35 miles; thence down French Broad valley to Asheville, 22 miles; thence through Hominy Gap and up Richland Creek to Waynesville, 30 miles; thence through Balsam Gap and down Scott's Creek to Webster, 24 miles; thence across Tuckasugee River and Cowee Mountains to Franklin, 17 miles; thence across Nantahala River and down Shooting Creek to Hiwassee, 32 miles; thence up Hiwassee River and down the Chatahoochee to Nacoochee, White County, Georgia, 25 miles, part of this line being along an old Indian trail. As the distance from Silver Bluff to Anderson is about one hundred miles, two or three more or less, this makes the entire distance along this supposed route from Cofitachiqui to Guaxule three hundred and eleven miles, and from Cofitachiqui to Xuala, one hundred and sixty-one miles, and from Xuala to Guaxule one hundred and fifty miles.

Though the route actually traveled according to this theory may not have been precisely that laid down, it must have been near to and parallel with it, and the distance and character of the country were substantially the same.

Our reasons for rejecting this theory are as follows: First, the distance, at least between some of the points, is too great to have been traveled by the army with its incumbrances, among which was a drove of hogs, in the time specified. These hogs may by constantly moving have become good travelers, and may have accomplished the trip from Cofitachiqui to Xuala, a distance of about one hundred and sixty miles, in twelve days—the longest time given by any of the chroniclers. But when the distance from Xuala to Guaxule, which on this route was at least one hundred and fifty miles, has to be traveled in five days, the time given by all the chronicles—a rate of thirty miles per day—the requirement becomes

an utter impossibility for an army thus hampered, and scarcely possible for an army free from these incumbrances, especially through a rough and densely wooded country where there were no other roads than narrow pathways.

This route places Xuala on the west or north of the Blue Ridge which has to be crossed in going from Greenville to Hendersonville.

Another insuperable objection to this route is that it requires us to assume that the territory of the cacica extended into western North Carolina, or included a detached section therein with the Sara or Cheraw, a Siouan tribe, as subjects, hedged in between the Cherokees and the Catawbas. This would be extraordinary.

This assumption is absolutely necessary, if we follow the theory in question, as it is clear, from all the chronicles, that Xuala was under the cacica's control. It is even stated by one chronicler that after she made her escape, which occurred between Xuala and Guaxule, it was ascertained that she was at the former village where she and the negro Robles, who escaped at the same time, were living as husband and wife. The assumption of this route requires not only the supposition that the Cheraws were her subjects and their country in her kingdom, but also when she escaped she went back northward into western North Carolina instead of continuing southward to her own proper capital. It also necessitates the supposition that her flight was mostly through Cherokee country, where she would more likely have been taken captive and possibly slain than kindly concealed and helped on her way.

Another reason for rejecting this theory is that it places Guaxule in White County, Georgia, where no mound of the character described is known to exist or to have existed. It is claimed by advocates of the theory that there is a mound which will answer the description near Clarksville. This, however, is a mistake. There is, it is true, a mound in that locality, but it will by no means fill the requirements. It is in the upper part of Nacoochee valley, near its western extremity,

and it is only about, or a little over, twenty feet high, elliptical in form and flat on top. Its base diameters are 190 and 150 feet and its top diameters 90 and 60 feet. There are no evidences of terraces or a graded way; the sides slope gradually from the summit. It has been plowed over for many years, but this would not have effaced entirely a terrace or graded way had there been one. Moreover, there were no such indications extant half a century ago. There is, however, a mound in Bartow County, Georgia, which does fully meet the requirements of the chroniclers' descriptions.

Another reason for rejecting this route is that it follows down the Chattahoochee River instead of the Coosa; in other words, eliminates the 'Coza' for which the Adelantado was in search, and which his successors endeavored to reach. Hamlet is taken out of the play unless the name 'Coza' is transferred to Chattahoochee.

Another reason for considering this theory erroneous is that although the army must have passed through Cherokee territory after leaving Xuala, if this route was followed, no mention whatever of this fact is made by any of the chronicles.

Finally the theory is erroneous because it is based on a mistake. It is apparent, from the statement of the author we have been referring to, that the conclusion reached by others, that Xuala was in northeastern Georgia, was set aside because he had ascertained, as he believed, that there was formerly a tribe of Indians named Suali or Suala in western North Carolina; hence as Xuala might be pronounced Shuala, the two must be one and the same people, in fact he says (Nineteenth Annual Rep. Bureau of Eth., Pt. 195): "As the province of Chalaque is the country of the Cherokee, so the province of Xuala is the country of the Suali or Sara Indians, better known as the Cheraws."

On this slender foundation of a slight resemblance in names does the theory appear to be built, which takes De Soto and his army, with their hogs and other incumbrances, into the 'piedmont region of North Carolina.'

The objection, however, does not stop here, for the statement that there was an Indian

tribe in southwestern North Carolina known as Suali or Suala appears to be based solely on the name as used by John Lederer in his 'Discoveries in Three Several Marches' (1672). But it has been shown (*American Anthropologist*, N. S., Vol. 5, No. 4, 1903) that his reputed expedition into Carolina is clearly a fiction, that he was never nearer this point than along the southern border of Virginia, his statements in regard to this section are, therefore, unreliable. What few facts he mentions being obtained, in all probability, from the Indians along Roanoke River, and from the accounts of other earlier explorers, with which he seems to have been familiar.

His name Suali or Suala seems to refer to De Soto's Xuala, of which he appears to have obtained knowledge; in fact, he states that it was obtained from the Spanish. As he knew it was somewhere in the direction of his imaginary journey without any knowledge as to distance, he uses the name to give weight to his fictitious narrative. Distance would have troubled a writer but little who definitely placed a great lake in western North Carolina and believed that the Pacific laved the western slope of the Alleghanies.

Unfortunately, however, for the theory, Lederer nowhere applies the name to the Indians, but throughout expressly limits it to mountains, giving the name Sara to the Indians. The theory, therefore, as given is absolutely without a foundation stone, as the name Suali or Suala was never applied to Indians so far as we are able to ascertain until Mr. Mooney so used it in his 'Siouan Tribes of the East.'

Believing the foregoing reasons to be entirely sufficient for rejecting the theory that Xuala was in the 'piedmont region of North Carolina,' we next proceed to give our reasons for believing that this village or province was located in northeastern Georgia, and Guaxule in northwestern Georgia, most likely in Bartow County.

In attempting to trace that portion of De Soto's route now under discussion it is best to accept what seems to be the most satisfactory evidence in regard to one particular locality mentioned. One item is given by Gar-

cilasso in respect to Guaxule that appears to fix this town, beyond any reasonable doubt, at the mound group near Cartersville, Bartow County, Georgia. The statement of this author is as follows: "La casa estava en un cerro alto, como de otras semejantes hemas dicho. Tenio toda ella el derredor un paseadero que podian pasearse por el seis hombres juntos." "The house [of the chief] stood on a high hill [mound] similar to others we have already mentioned. It had round about it a roadway on which six men might march abreast."

The 'similar to others we have already mentioned' is evidently intended to signify it was artificial, and this is admitted by all who allude to it. The statement that it was 'high' signifies more, in the eyes of the Spaniards, than an ordinary elevation. The large mound of the Etowah group near Cartersville, Bartow County, Georgia, is 66 feet high with base diameters of 380 and 330 feet, and top diameters about 160 and 180 feet. Running up the south side is a broad roadway varying in width from 37 to 56 feet. In bulk it is next in size to the great Cahokia mound near St. Louis. Here then we have a mound which will completely satisfy the description, and the only one in all that section of the south—as is now positively known—which will do so. Moreover, it is sufficiently near Canasauga River to agree with the narrative. There is no reason, therefore, except to maintain a theory, why this should not be accepted as the site of Guaxule. Assuming this as one fixed point, the possibilities of the position of Xuala become much more limited than without this determination.

As the suggestion above mentioned, that the Chalaque villages were near the Keowee River, may be accepted as probably correct, it is apparent from the limited time of the march from Xuala to Guaxule—five days—that we must place the former town somewhere in northeastern Georgia, probably in White or Hall County or in that section. A statement by Biedma appears to have a decided bearing on this question; it is as follows:

Again we took the direction of the north, and for eight days we traveled through a poor country, scarce of food, until arriving at one called Xuala,

where we still found some Indian houses, though a sparse population, for the country was broken. Among these ridges we discovered the source of the great river by which way we started, and which we believed to be the Espiritu Santo. We went on to a town called Guasuli, where the inhabitants gave us a number of dogs, and some maize, of which they had but little; whence we traveled four days and we arrived at a pueblo which was called Chiha, which possessed more food; this is situated on an island of this river of the Espiritu Santo, which from its source has large ones (islands).

That they struck the headwaters of Coosa River, which they thought was the Espiritu Santo (Mississippi), and that they followed it down to Chiaha seems evident, for the description of this river by Biedma in the foregoing citations fits no other river in this region than the Coosa.

This supposition is apparently confirmed by the earliest known map of De Soto's route, made before Tristan de Luna started on his expedition, given by Harrisse in his 'Discovery of North America.' In this a river is laid down about the same locality as the Coosa (and Etowah) running westward marked with islands and towns. It is continued westward, however, to the Mississippi and was evidently drawn to correspond with Biedma's statement, regardless of the fact that De Soto and his followers must have learned at length that it did not extend to the Mississippi. This fact, however, was overlooked by the map-maker.

CYRUS THOMAS,

J. N. B. HEWITT.

BOTANICAL NOTES.

THE STUDY OF PLANT MORPHOLOGY.

NEARLY twenty years ago Professors Arthur, Barnes and Coulter published a useful book on the morphology of plants under the title of 'Handbook of Plant Dissection.' It included suggestions for studies of a dozen representative plants selected from all parts of the vegetable kingdom. These authors finding themselves unable to undertake the re-writing of the book for a new edition delegated the task to a younger man, Professor O. W. Caldwell, who brings it out under the new title 'Handbook of Plant Morphology'